Changing Ecology and Vector-borne Diseases – The wildlife perspective

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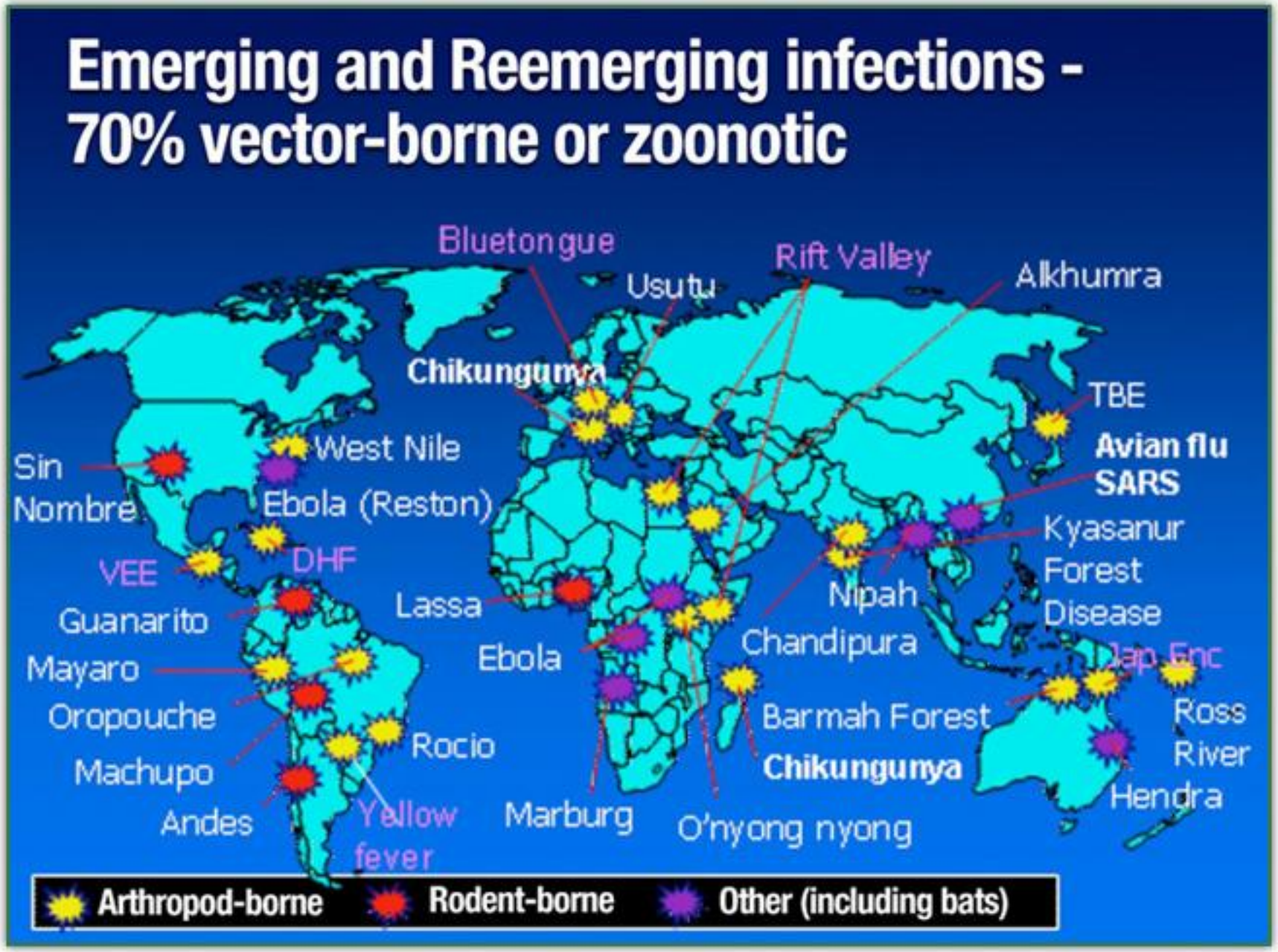
Emerging and Reemerging infections - 70% vector-borne or zoonotic



Agents

- Rickettsial diseases
- Mosquito-borne diseases
- Lyme disease and STARI
- Chagas disease
- Bartonellosis
- Babesiosis

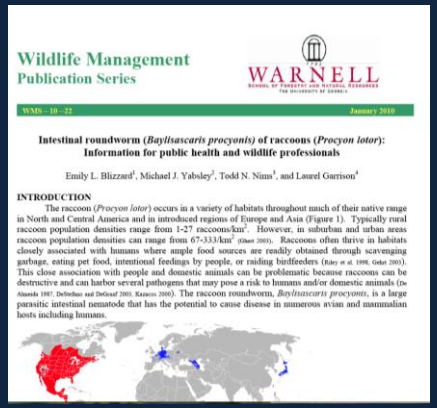
Why include wildlife in the "One Health" approach?

- Reservoirs
  - Understanding the ecology of pathogen
  - Risks of transmission
  - Potential vectors
  - Diverse pool of pathogen samples
    - Genetic gold mine
- Sentinels
- Necessary or important host to vectors (ticks)
- Wildlife as victims of disease
- Education

Changing ecology and vector-borne diseases

- What is the role of wildlife?
- How are wildlife populations changing?
  - Effects on pathogens and vectors?
- How does this translate into human or animal health risks?

Wildlife and disease: Complex system


Wildlife Management Publication Series

WARNELL

WMS – 10 – 22 January 2010

Intestinal roundworm (*Baylisascaris procyonis*) of raccoons (*Procyon lotor*): Information for public health and wildlife professionals

Emily L. Blizzard[1], Michael J. Yabsley[2], Todd N. Nims[3], and Laurel Garrison[4]

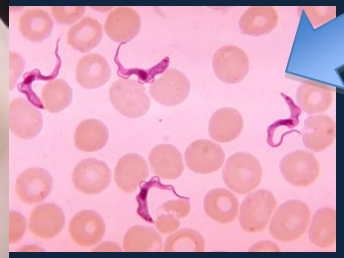
INTRODUCTION

The raccoon (*Procyon lotor*) occurs in a variety of habitats throughout much of their native range in North and Central America and in introduced regions of Europe and Asia (Figure 1). Typically rural raccoon population densities range from 1-27 raccoons/km². However, in suburban and urban areas raccoon population densities can range from 67-333/km² (Glueck 2003). Raccoons often thrive in habitats closely associated with humans where ample food sources are readily obtained through scavenging garbage, eating pet food, intentional feedings by people, or raiding birdfeeders (Riley et al. 1998, Gehrt 2003). This close association with people and domestic animals can be problematic because raccoons can be destructive and can harbor several pathogens that may pose a risk to humans and/or domestic animals (De Almeida 1987, DeStefano and DeGraaf 2003, Kazacos 2008). The raccoon roundworm, *Baylisascaris procyonis*, is a large parasitic intestinal nematode that has the potential to cause disease in numerous avian and mammalian hosts including humans.

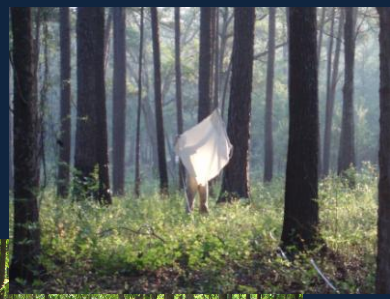
Education/policy/management


Lab work/characterization


Diagnostics



Wildlife biology
Virology
Bacteriology
Parasitology
Toxicology
Clinicians
Landscape modelers
Disease ecologists

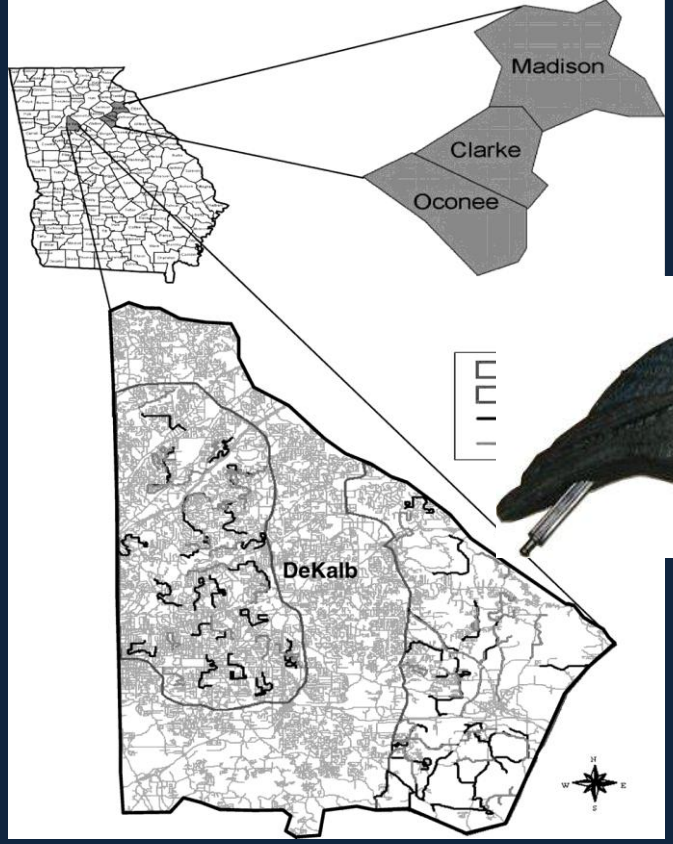



Field surveillance

Field investigations

Complex system

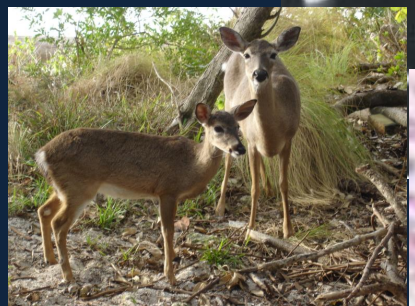
- Mortality rate
  - Mortality detection!
- Diagnostic difficulties
  - Molecular and serologic
- Experimental studies



Ward et al., 2006

Complex system

- Mortality rate
  - Mortality detection!
- Diagnostic difficulties
  - Molecular and serologic
- Experimental studies

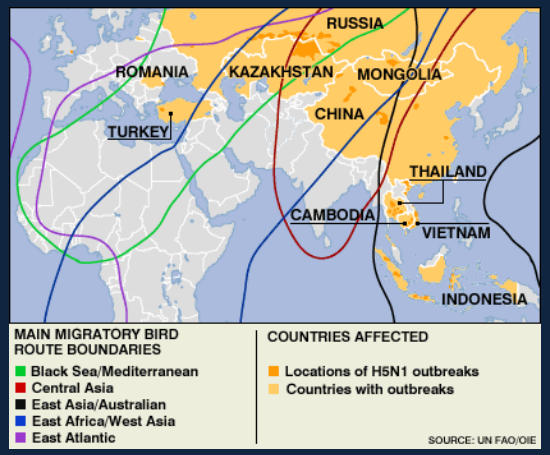


Complex system

- Mortality rate
  - Mortality detection!
- Diagnostic difficulties
  - Molecular and serologic
- Experimental studies

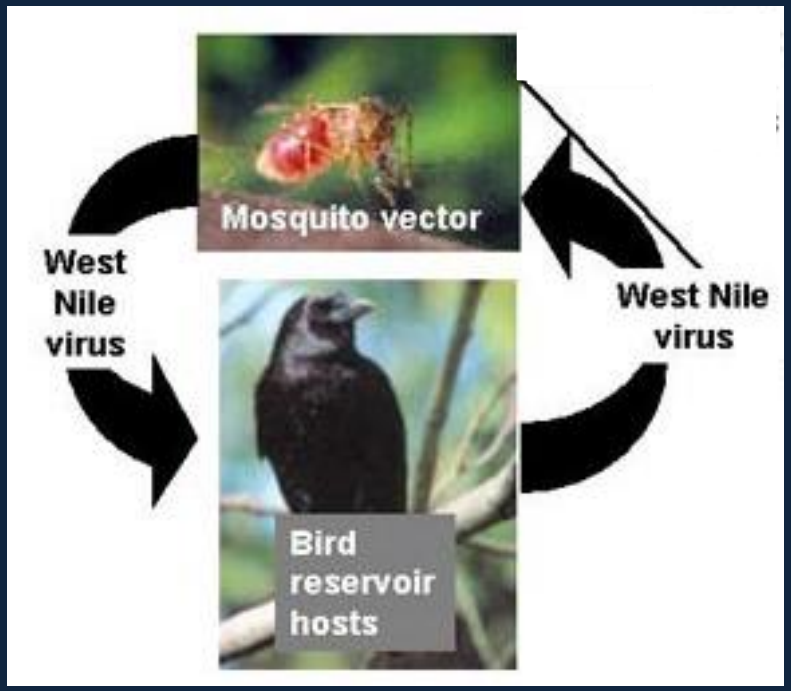
Complex system

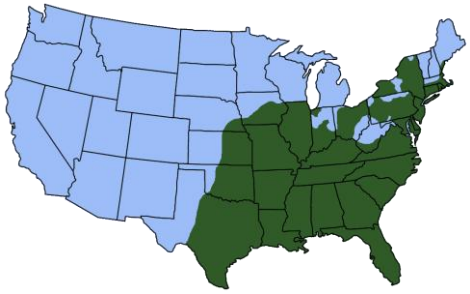
- Population data (need that denominator)
- Community composition
- Animal behavior
  - Spatial and scale considerations
- Habitat characteristics/changes
  - Predictability?



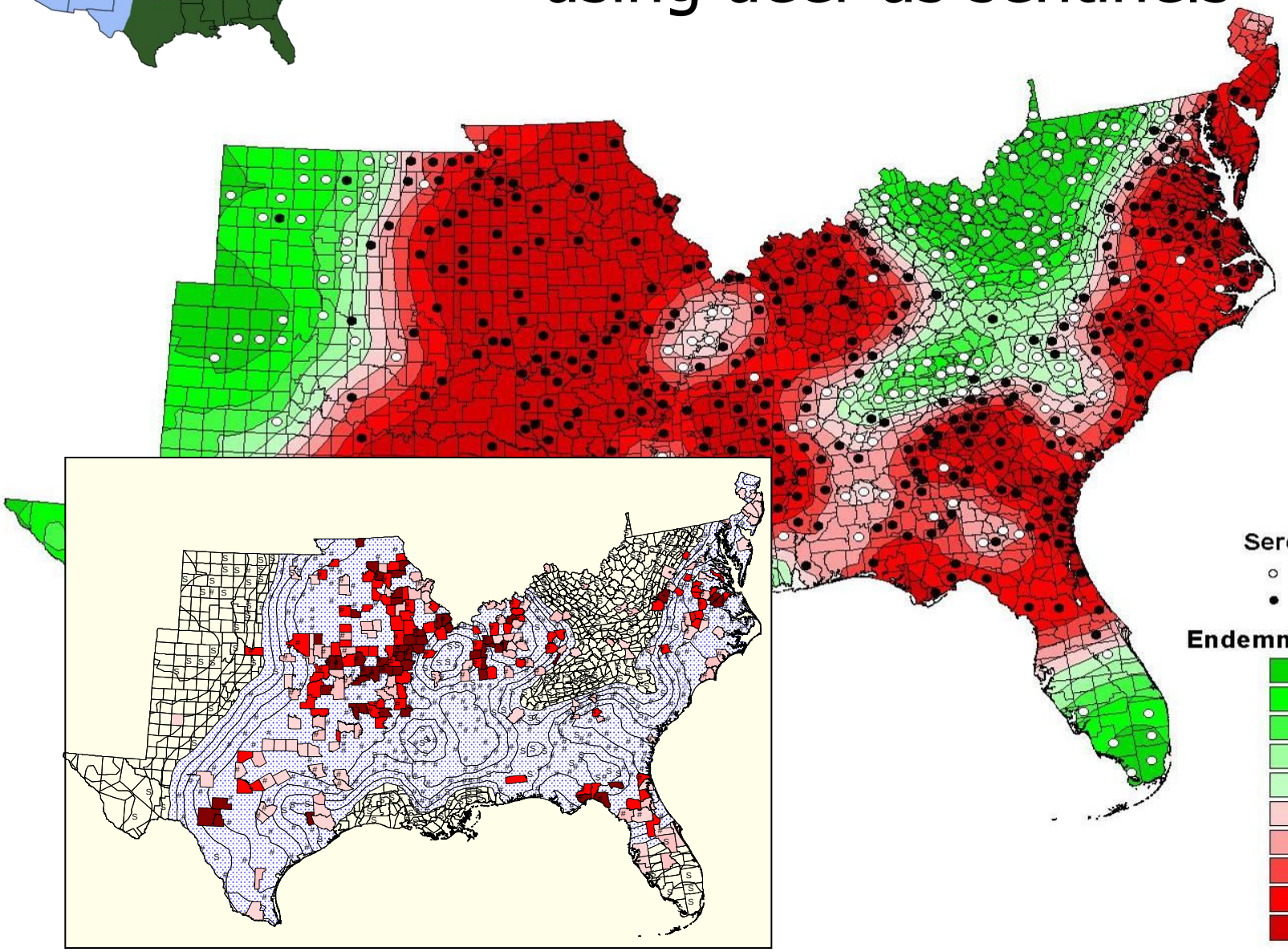
Reservoirs

- *Ehrlichia chaffeensis*, *Borrelia burgorderi*, arboviruses, avian influenza, etc.





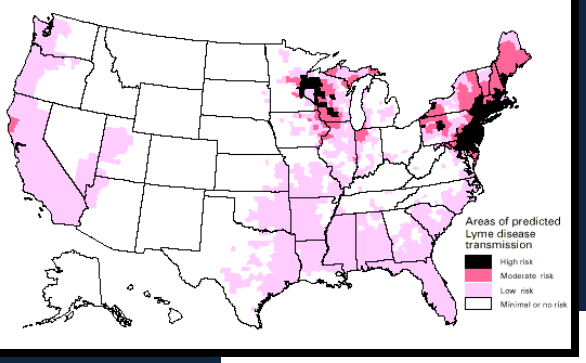
Ehrlichia chaffeensis surveillance using deer as sentinels



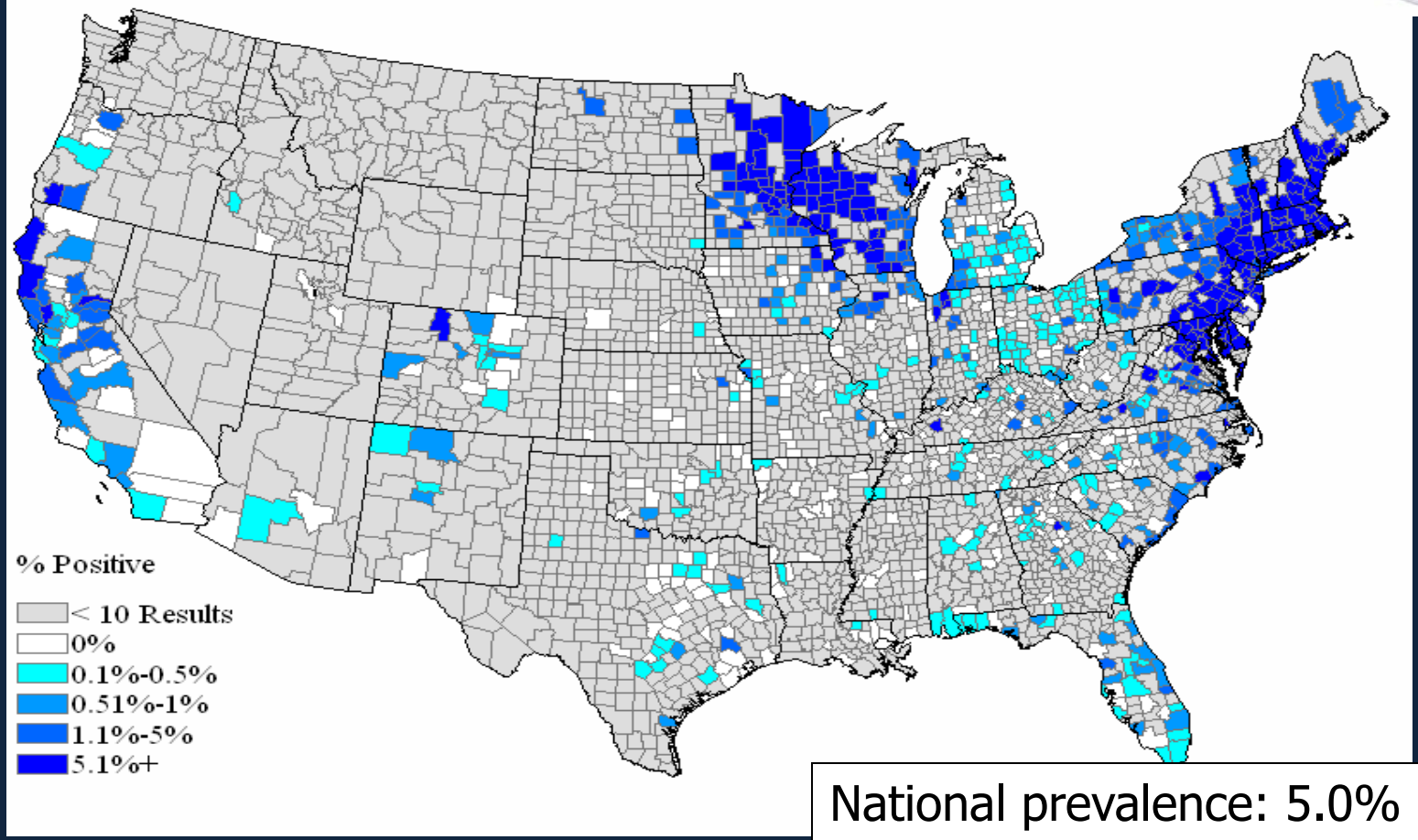
Yabsley et al., 2005; AJTMH

Sentinels

- Reservoirs
- Commonly exposed animals



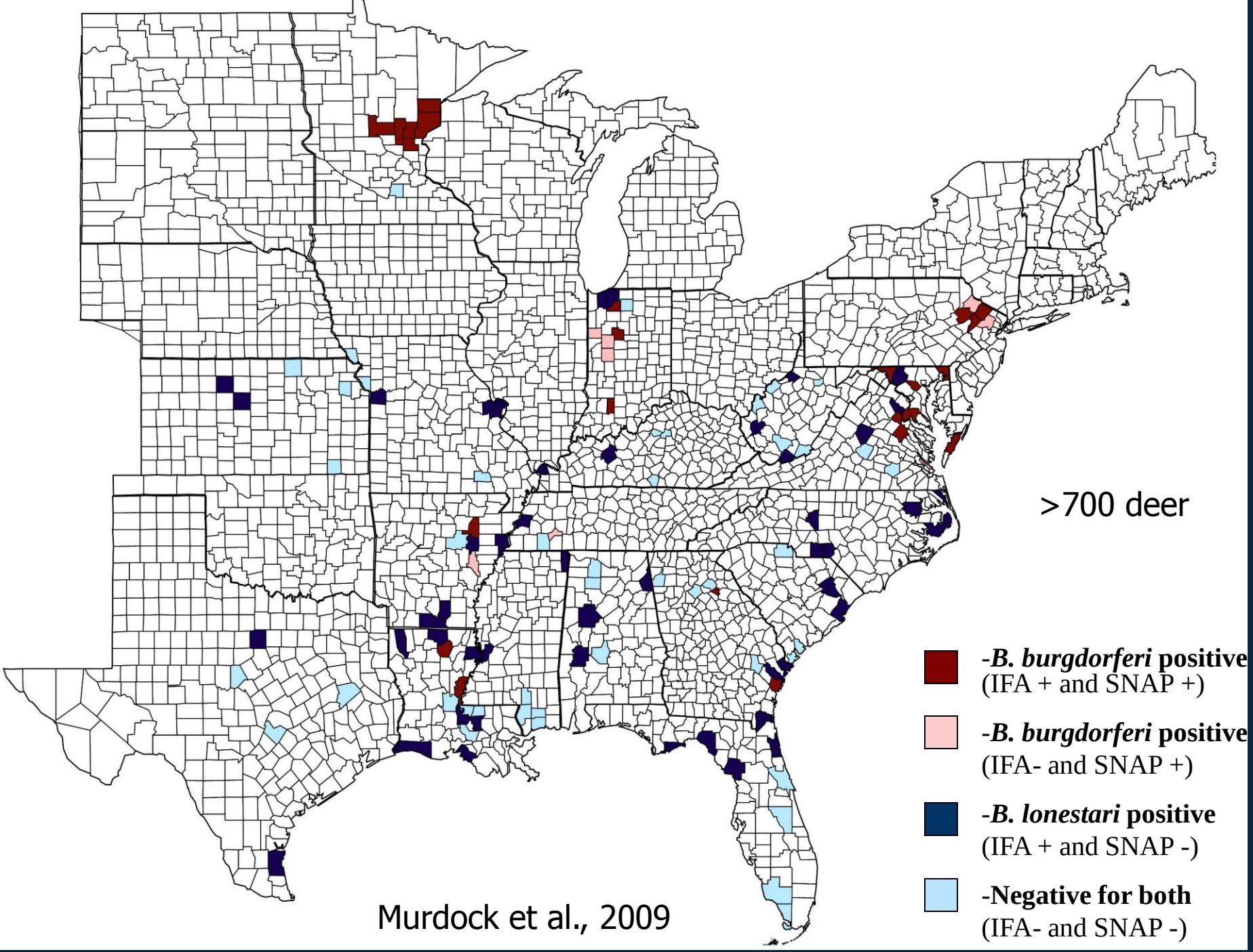
Dogs and *Bb*



National prevalence: 5.0%

Almost 1 million dogs tested

Bowman et al., 2009 Vet Parasitol


>700 deer
-*B. burgdorferi* positive
(IFA + and SNAP +)
-*B. burgdorferi* positive
(IFA- and SNAP +)
-*B. lonestari* positive
(IFA + and SNAP -)
-Negative for both
(IFA- and SNAP -)
Murdock et al., 2009

Raccoons and *Ehrlichia chaffeensis*

	E. chaffeensis Strain 604-5			
Days p.i.	*R407*		*R409*	
0	–	<64	–	<64
3	–	<64	–	<64
6	–	<64	–	<64
9	–	<64	+	<64
12	–	<64	+	256
15	+	<64	+	1024
18	–	<64	+	2048
21	–	<64	+	2048
24	–	<64	+	2048
27	–	64	–	2048
30	–	256	–	2048
41	–	512	–	2048
48	–	1024	–	2048

Agent	*Baker Co., GA* n = *13* *No. positive (%)*	*Chatham Co., GA* n = *51* *No. positive (%)*	*Clarke Co., GA* n = *23* *No. positive (%)*	*Leon, Liberty, and Wakulla Co., FL* n = *52* *No. positive (%)*	*Pinellas Co., FL* n = *13* *No. positive (%)*	*Broward Co., FL* n = *17* *No. positive (%)*
Ehrlichia chaffeensis						
Serology	0	18 (35.3)	7 (30.4)	24 (46.1)	n.a.[a]	0
PCR	0	0	0	0	0	0

Yabsley et al., 2008 VBZD

Spatial and pathogen effects

Anaplasma phagocytophilum

- Few human cases in the Southeast
  - 2006
    - New England, Mid. Atlantic, and N. Central – 613 cases
    - Southeast – 31 cases
  - Raccoons
    - Reservoirs of Ap in CT (Levin et al., 2002)
    - All raccoons tested in South are negative (Dugan et al., 2004; Yabsley et al., 2008)
    - Experimentally, raccoons develop long term infections with Ap-ha but short-term infections with Ap-Var1 (Yabsley et al., 2008)

Wildlife as victims of disease

- Depending on the pathogen/wildlife species, some may develop disease
  - E.g., West Nile virus and corvids

West Nile Virus Devastating U.S. Bird Populations

Thursday, May 17, 2007
Associated Press

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AP

A blue jay on the ground in South Easton, Mass., in a 2004 file photo.

WASHINGTON — Birds that once flourished in suburban skies, including robins, bluebirds and crows, have been devastated by West Nile virus, a study found.

Populations of seven species have had dramatic declines across the continent since West Nile emerged in the United States in 1999, according to a first-of-its-kind study.

The research, to be published Thursday by the journal Nature, compared 26 years of bird breeding surveys to quantify what had been known anecdotally.

• Click here to visit FOXNews.com's Natural Science Center.

"We're seeing a serious impact," said study co-author Marm Kilpatrick, a senior research scientist at the Consortium of Conservation Medicine in New York.

West Nile virus, which is spread by mosquito bites, has infected 23,974 people in confirmed cases since 1999, killing 962, according to the Centers for Disease Control and Prevention.

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Organ Regeneration. Invest Today.

But the disease, primarily an avian virus, has been far deadlier for birds. The death toll for crows and jays is easily in the hundreds of thousands, based on the number dead bodies found and extrapolated for what wasn't reported, Kilpatrick said.

It hit the seven species — American crow, blue jay, tufted titmouse, American robin, house wren, chickadee and Eastern bluebird — hard enough to be scientifically significant.

Only the blue jay and house wren bounced back, in 2005.

The hardest-hit species has been the American crow. Nationwide, about one-third of crows have been killed by West Nile, said study lead author Shannon LaDeau, a research scientist at the Smithsonian Migratory Bird Center in Washington. The species was on the rise until 1999.

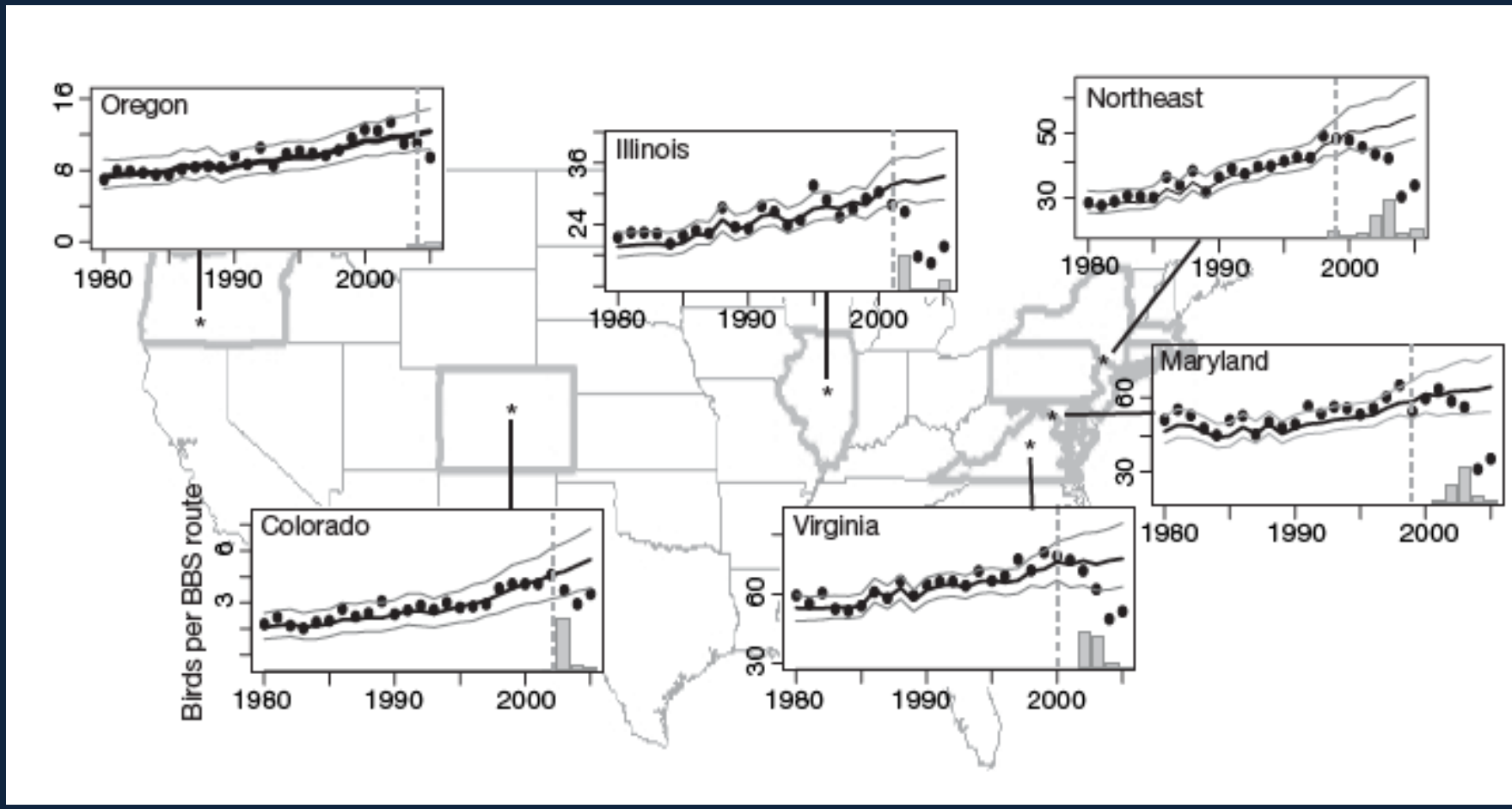
Wildlife as victims of disease

SHORT COMMUNICATIONS

The Condor 107:128–132
© The Cooper Ornithological Society 2005

WEST NILE VIRUS DEVASTATES AN AMERICAN CROW POPULATION

CAROLEE CAFFREY[1,2], SHAUNA C. R. SMITH[1] AND TIFFANY J. WESTON[1]
[1]*Zoology Department, Oklahoma State University, Stillwater, OK 74078*



LaDeau et al., 2007 Nature

Education

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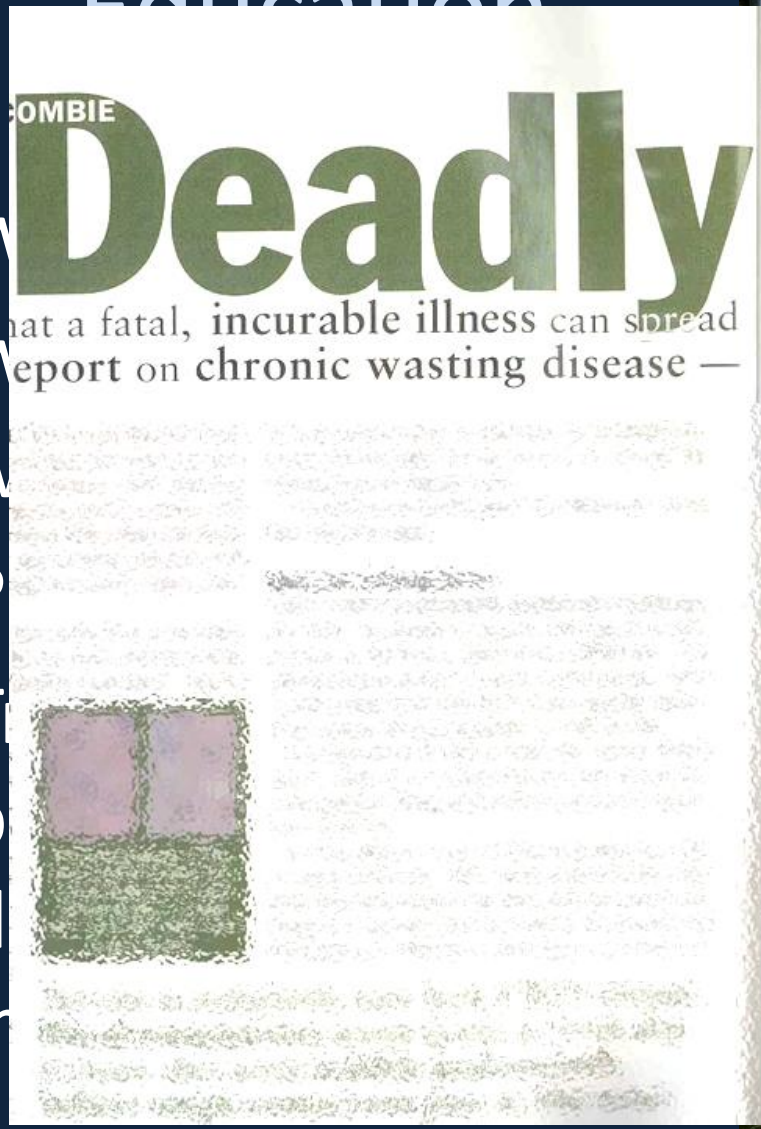
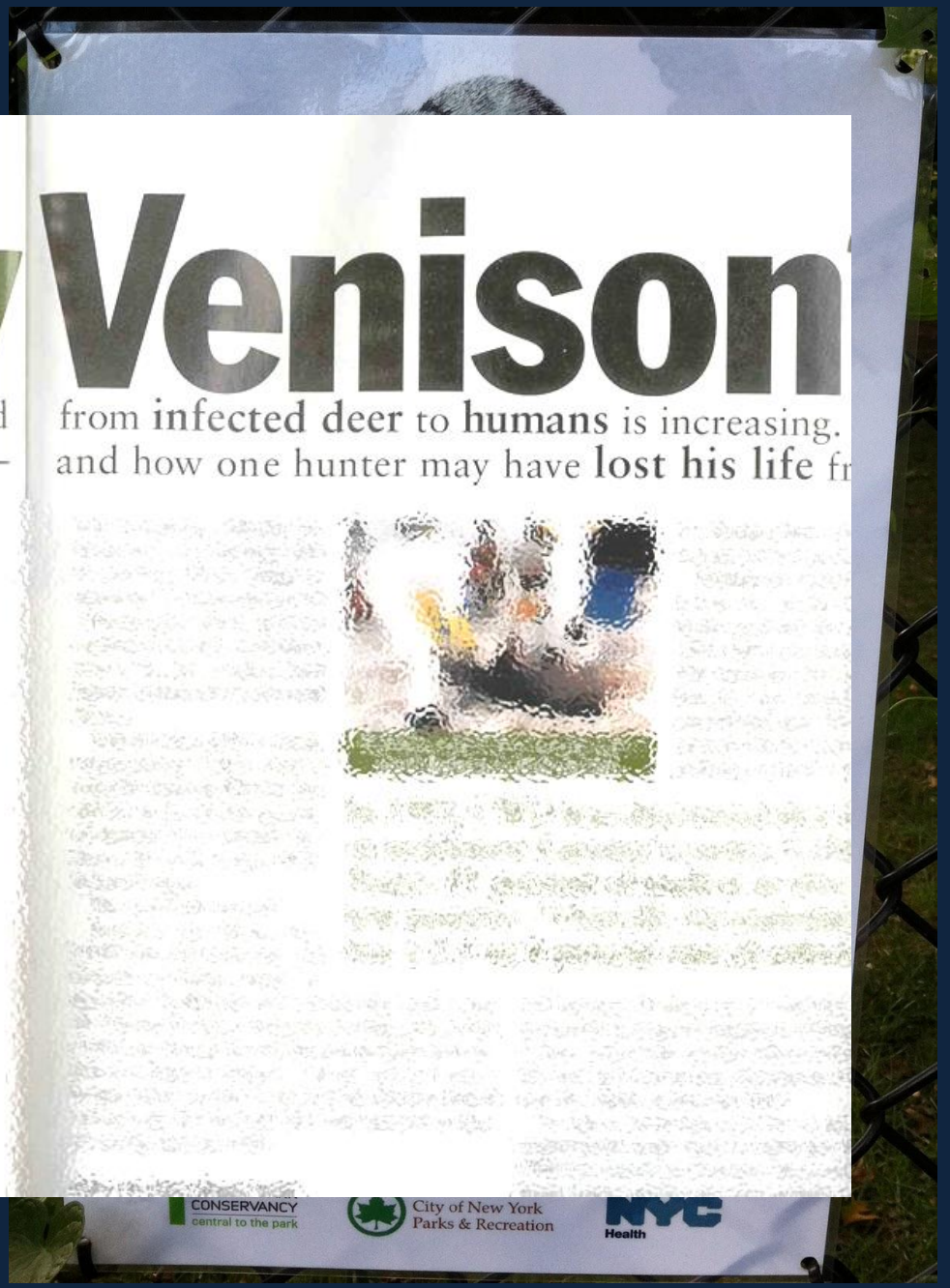




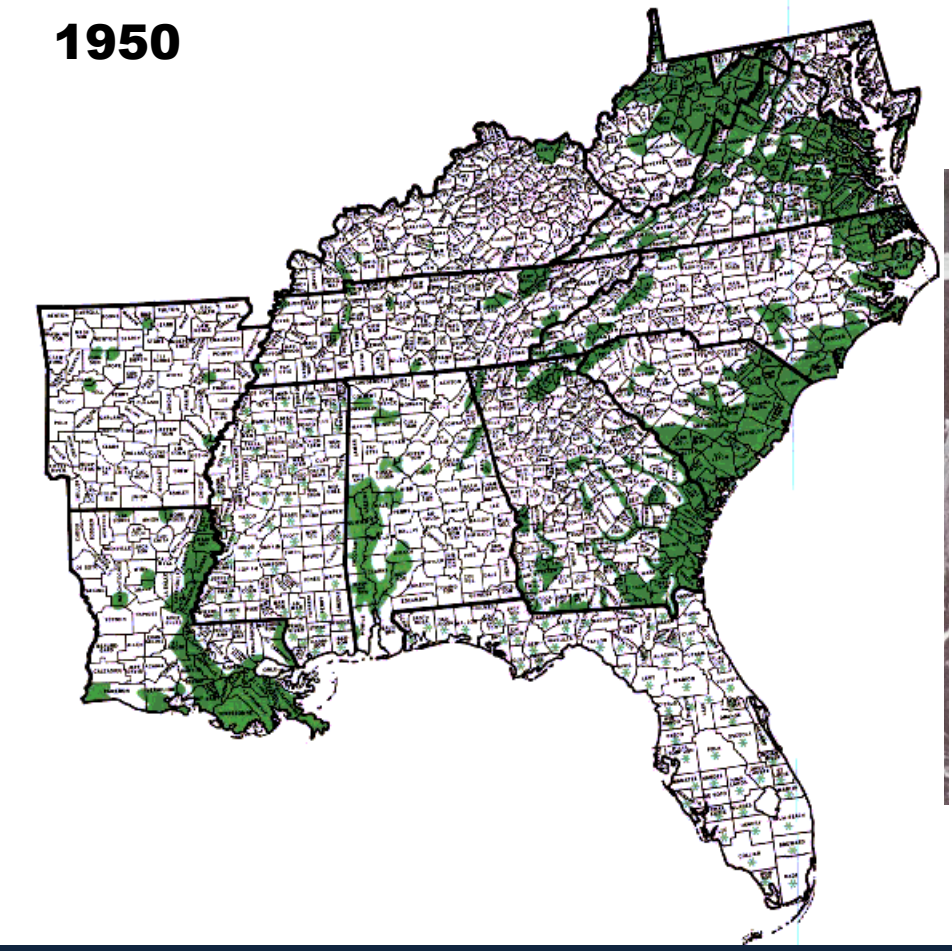
“Disease in a wildlife population is rarely a simple, one-cause, one-effect situation. Usually it is the product of profound changes in the environment”

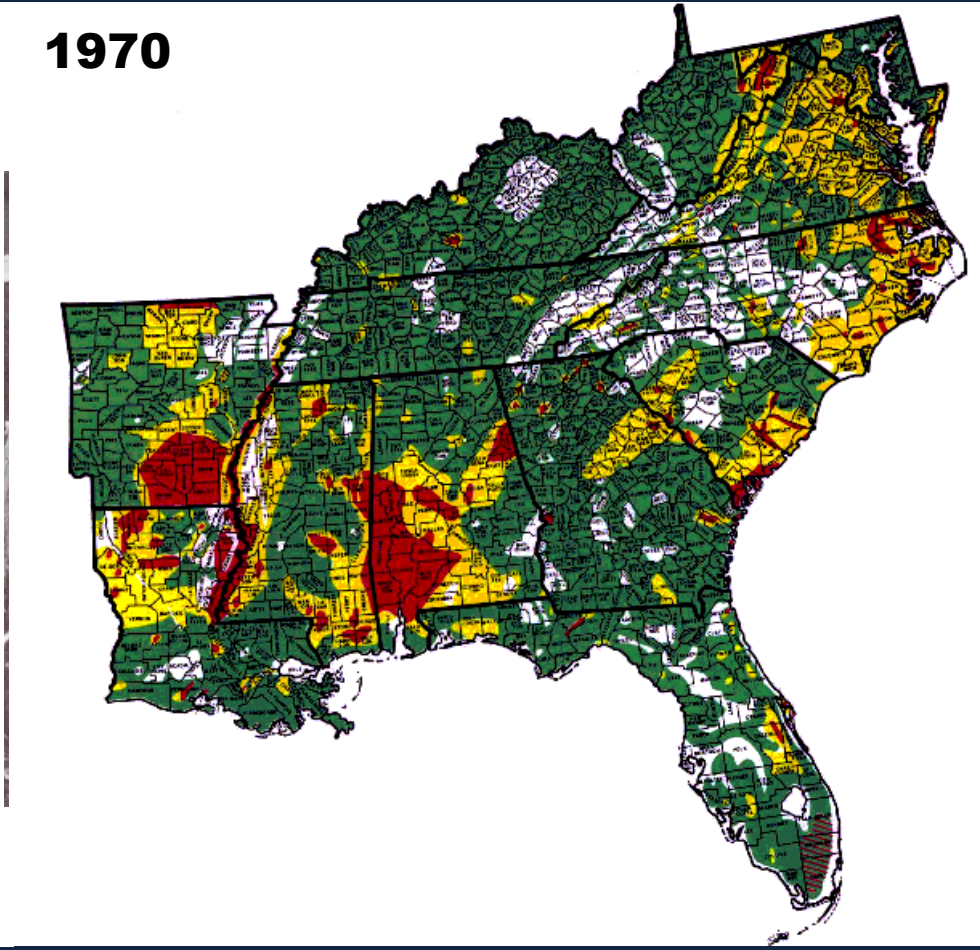
Lars Karstad, 1971

Changing landscape

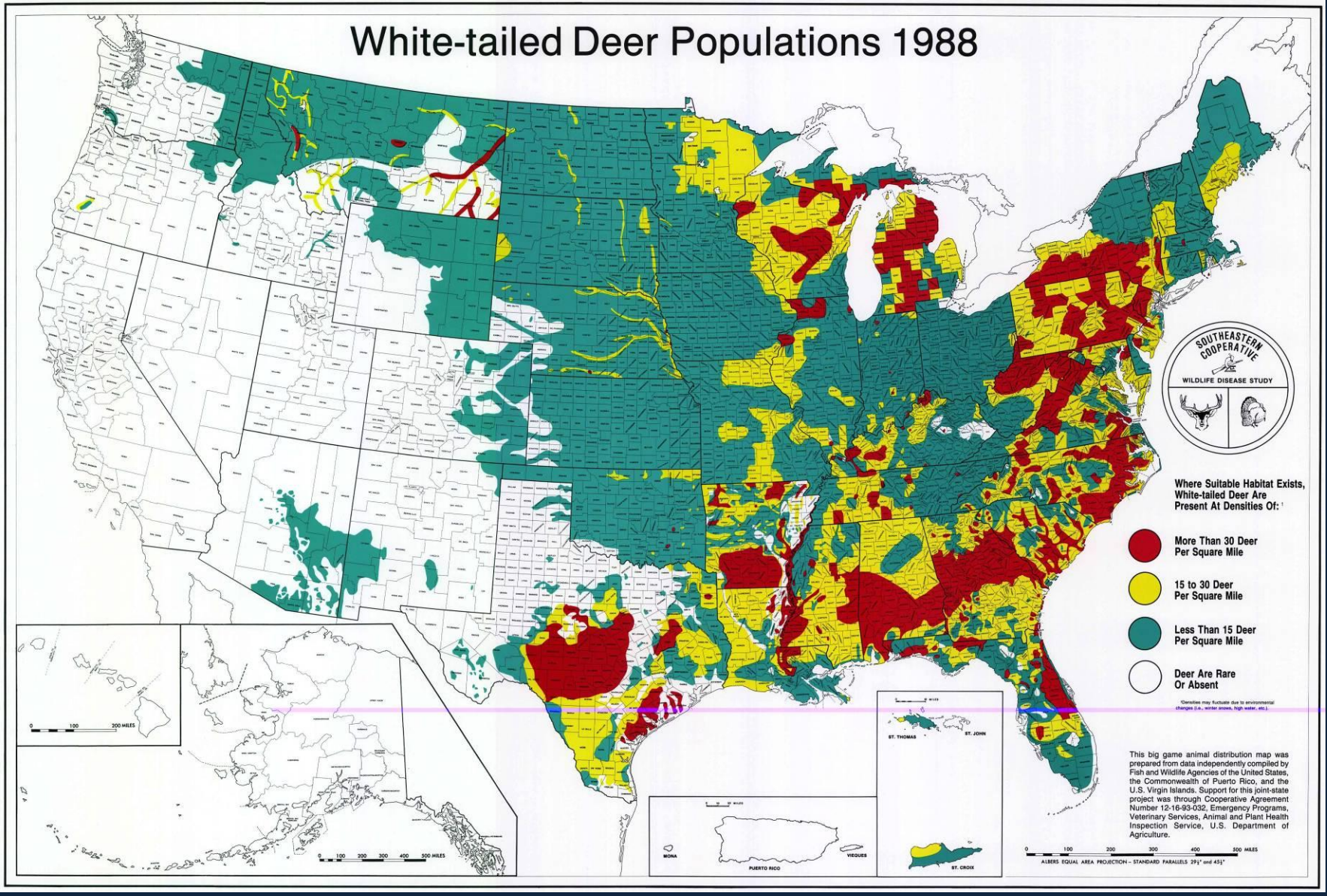
- Dramatic changes have occurred and will continue to occur
  - May affect disease dynamics in multiple ways
    - Pathogen prevalence
    - Reservoir hosts
    - Vectors
    - Changes in interactions of a pathogen with other organisms
    - People's behavior and demographics
    - Climate change

Changes in distribution and density of reservoir hosts

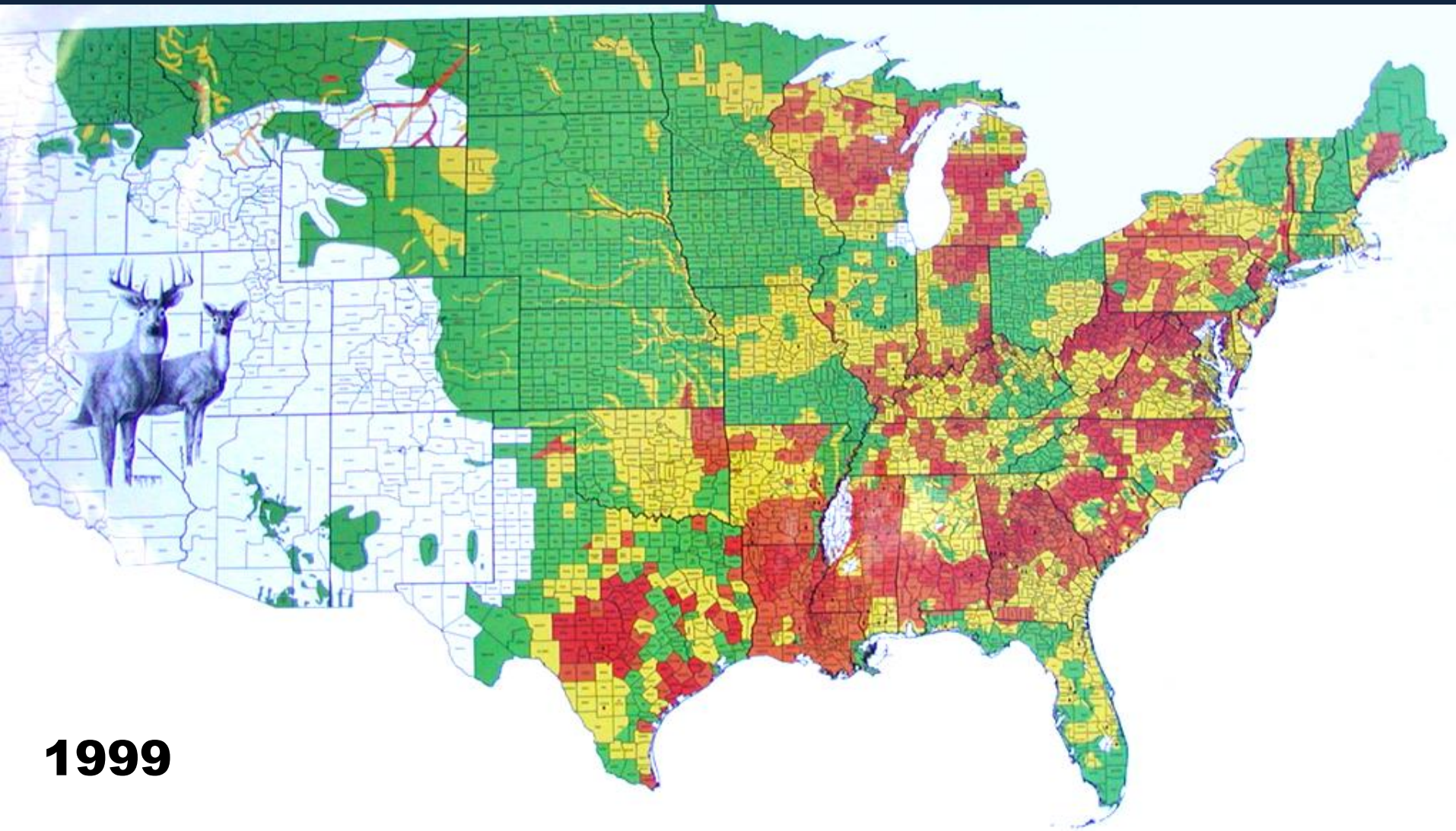




White-tailed Deer Populations 1988

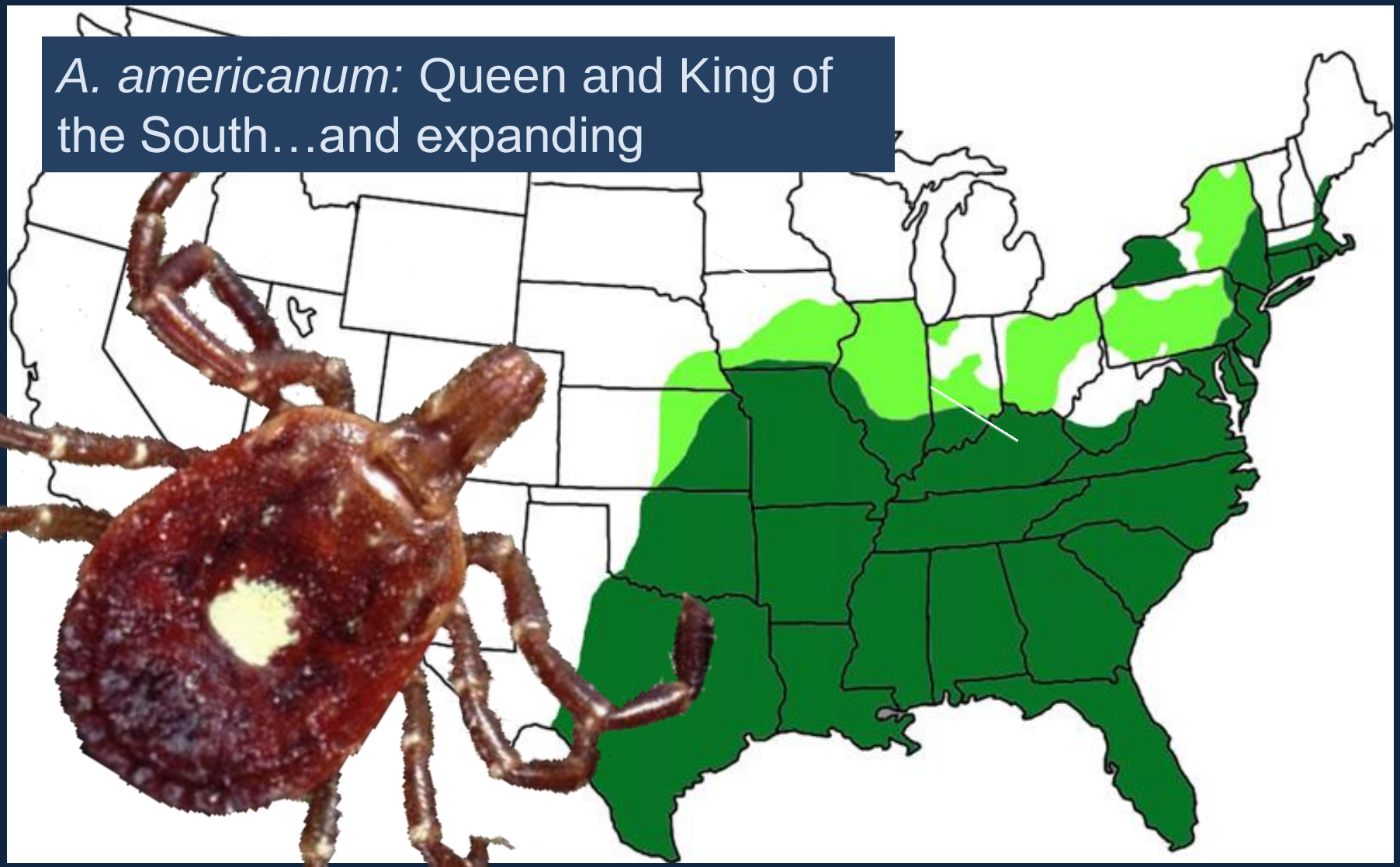


This big game animal distribution map was prepared from data independently compiled by Fish and Wildlife Agencies of the United States, the Commonwealth of Puerto Rico, and the U.S. Virgin Islands. Support for this joint-state project was through Cooperative Agreement Number 12-16-93-032, Emergency Programs, Veterinary Services, Animal and Plant Health Inspection Service, U.S. Department of Agriculture.



1999

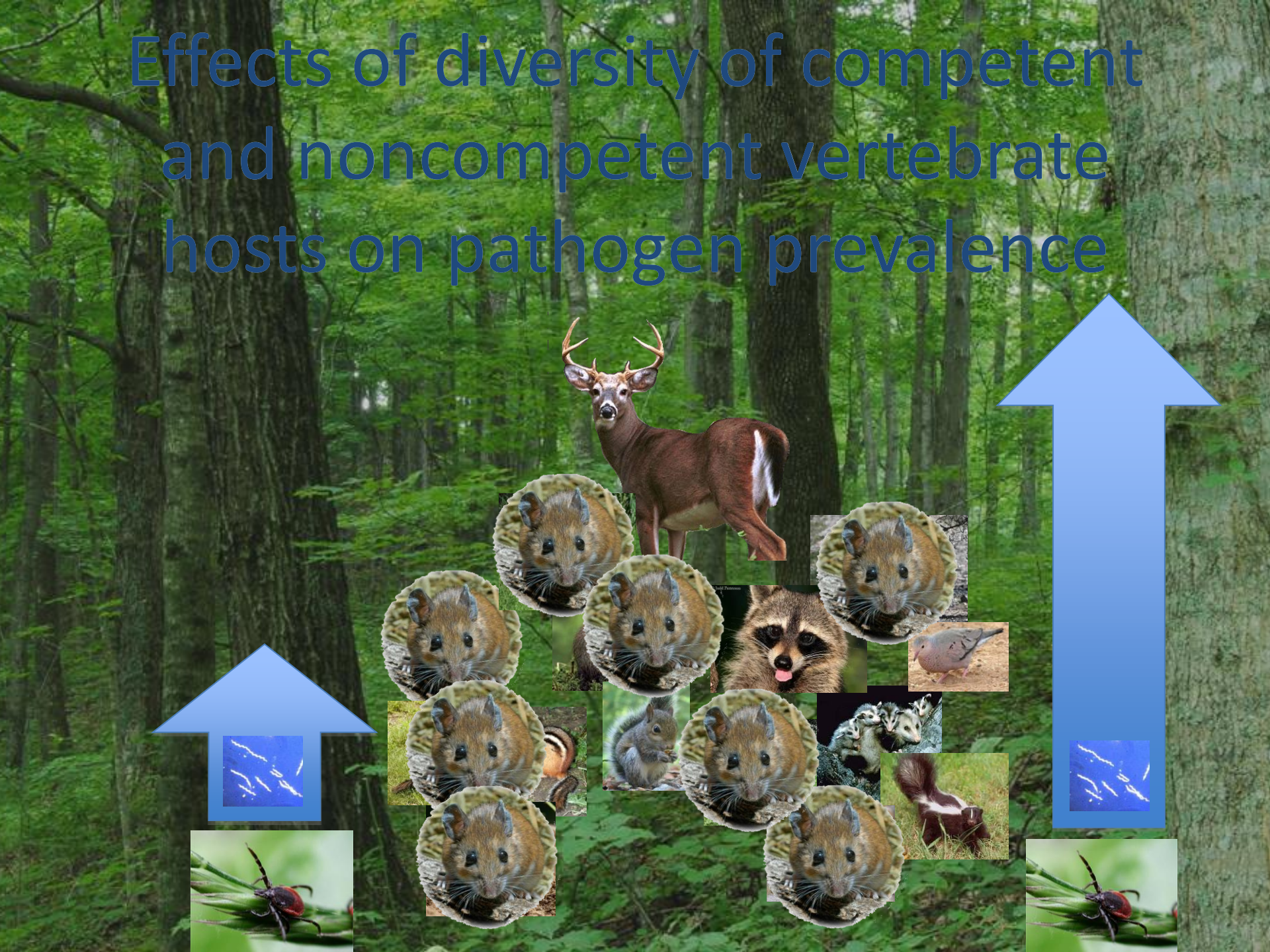
Changes in distribution and density of vectors



Changes in distribution and density of vectors

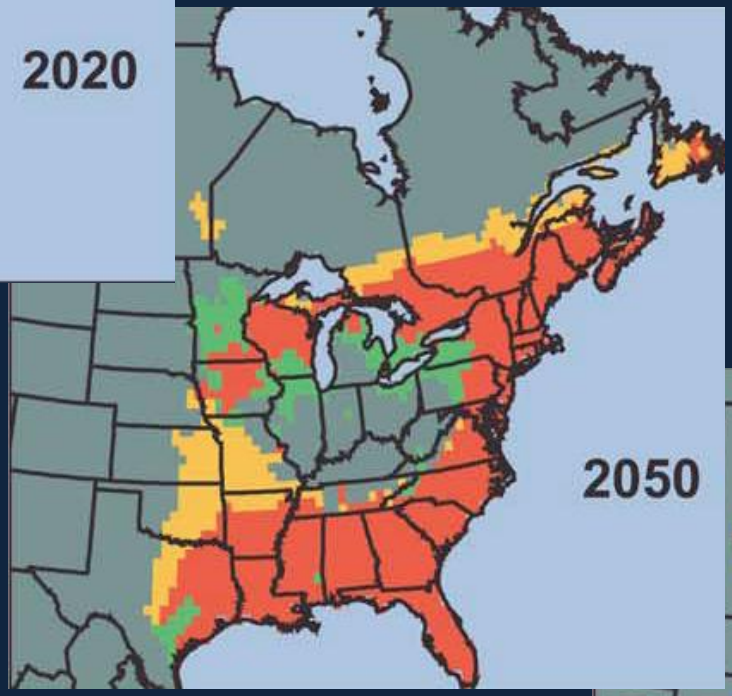
Gleim and Yabsley, unpub

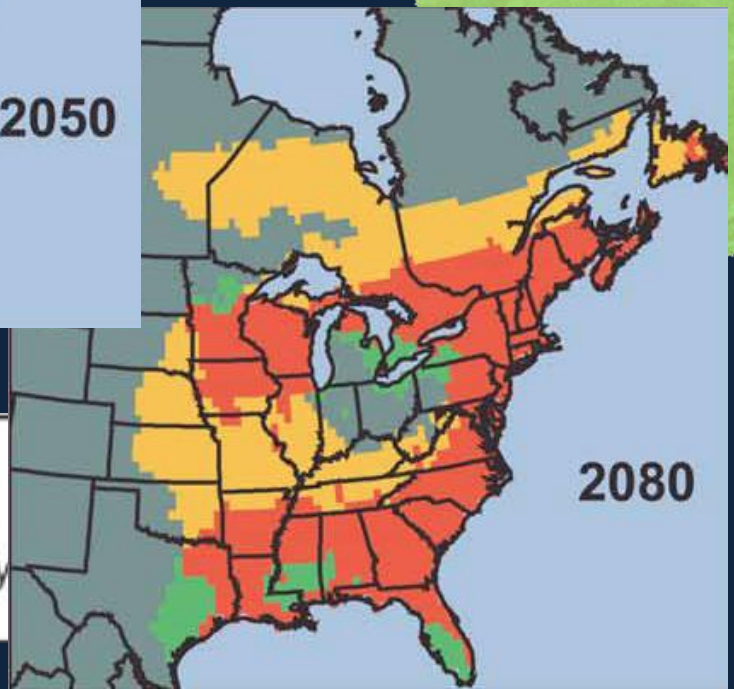
Effects of diversity of competent and noncompetent vertebrate hosts on pathogen prevalence



Changing demographics and behavior

Climate change





Browstein et al., 2005
EcoHealth

Example of a field-lab-wildlife-public health interaction: Discovery of a new pathogen…

PM *Ehrlichia* sp.

Discovery of PM *Ehrlichia* sp.

- Person hiking at Panola Mountain State Park near Atlanta, GA
- *A. americanum* from Panola Mountain State Park, GA transmitted agent to goats

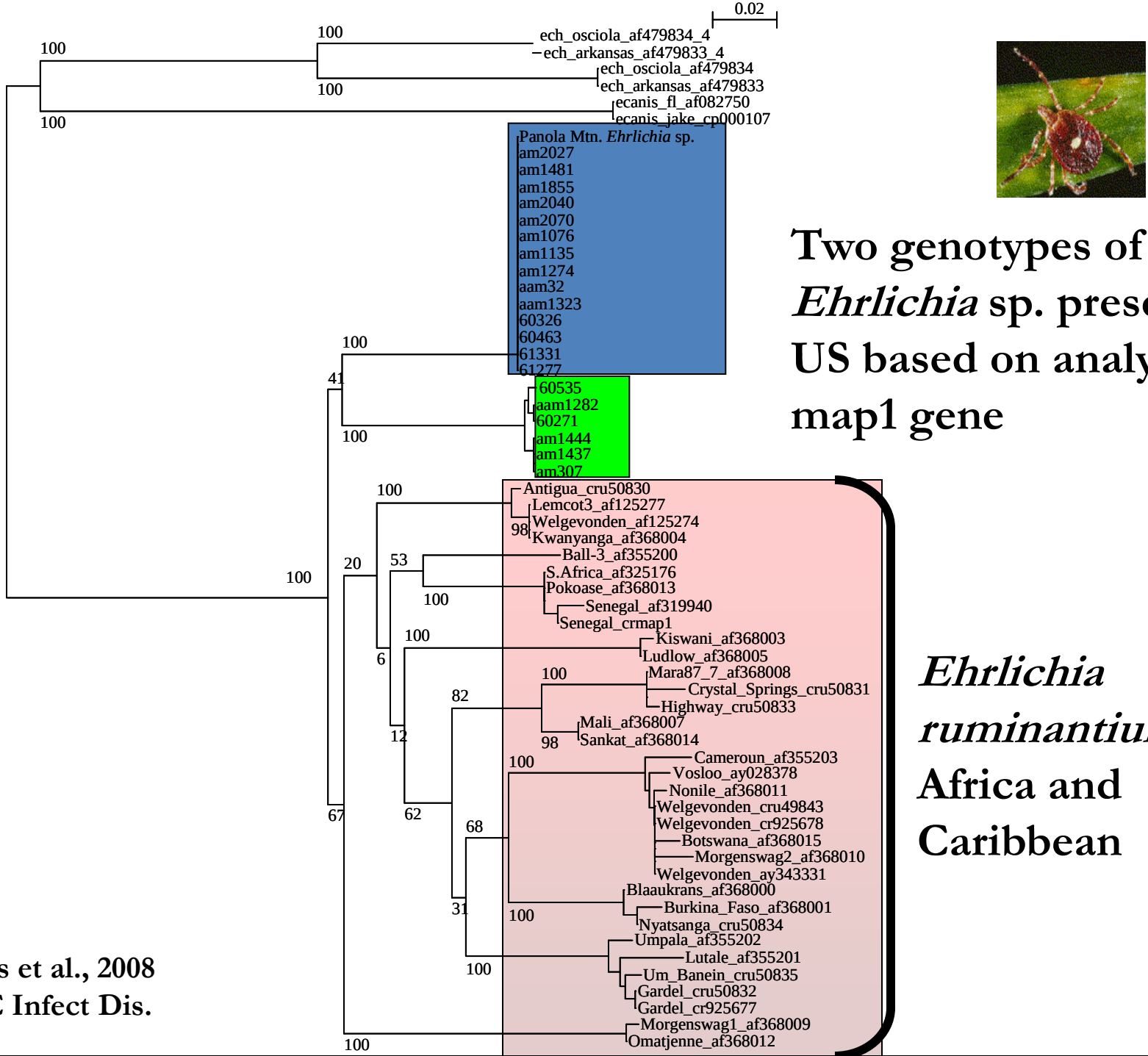
Reeves et al,. 2008, J Med Case Reports
Loftis et al., 2008 Vet Microbiol

36 of 3,799 ticks positive from 10 states

PCR-positive ticks

PCR-negative ticks

Loftis et al., 2008 BMC Infect Dis.



Two genotypes of PM *Ehrlichia* sp. present in US based on analysis of map1 gene

Ehrlichia ruminantium from Africa and Caribbean

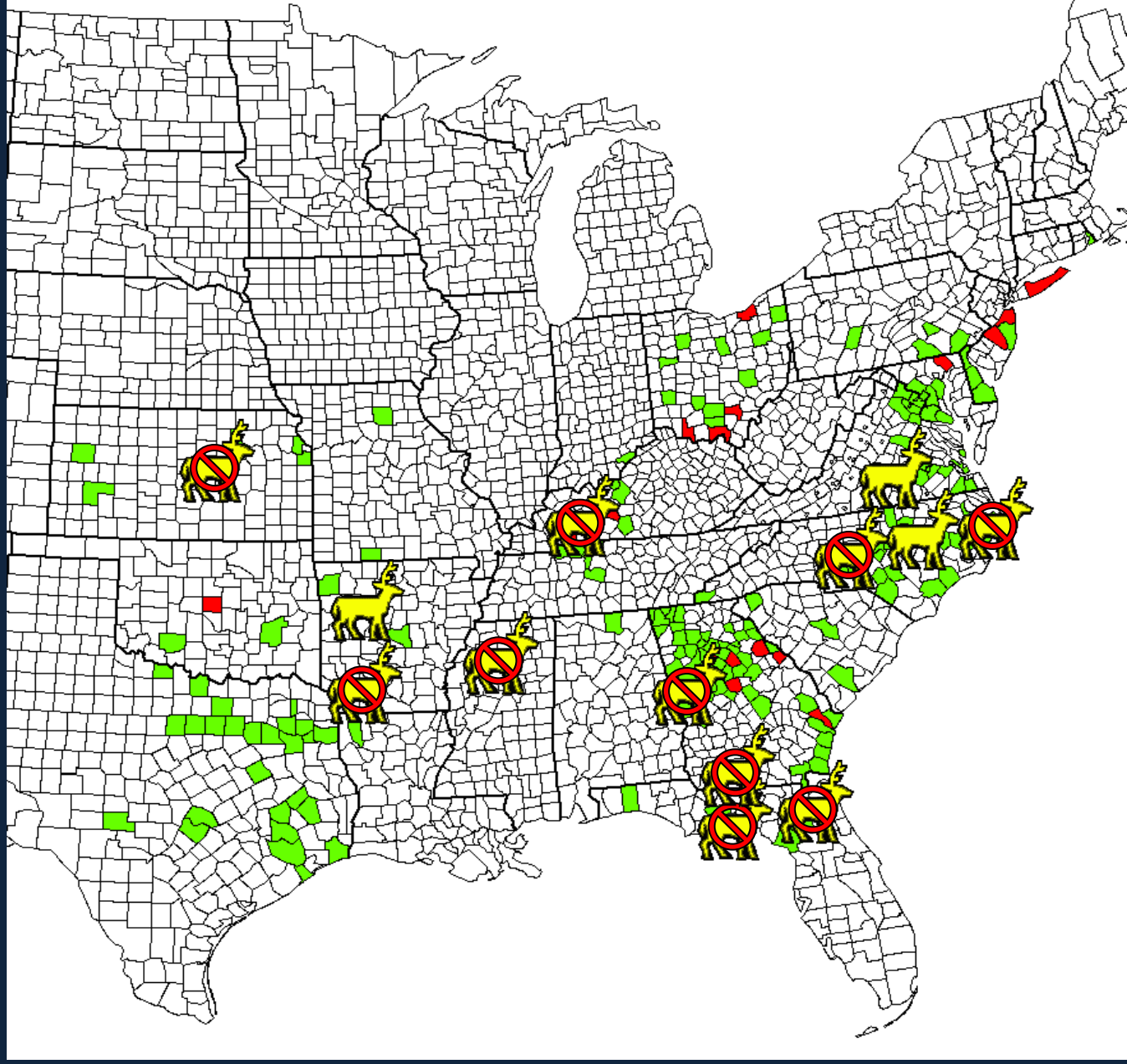
Loftis et al., 2008
BMC Infect Dis.

Deer as reservoirs?

3 of 87 (3.5%) positive

PCR positive

PCR negative



Yabsley et al., 2008, JWD




	Days post–tick exposure (DPTE)																	Tissues positive at necropsy[a]
	0	2 or 3	7	10	14	17	21	24	27	29	31	34 or 35	38	41 or 42	45	49	52	56	
Deer exposed to wild-caught ticks																			
Deer 12	—	—	—	nd[b]	—	nd	nd	—	—	—	—	—	nd	—	nd	—	nd	—	None
Deer 18	—	—	—	nd	—	nd	nd	+	+	+	+	+	nd	+	nd	—	nd	—	None
Deer exposed to experimental ticks																			
Deer 8	—	—	—	—	—	—	—	—	+	nd	nd	+	+	—	—	—	—	—	MLN, BM, LU
Deer 32	—	—	—	—	—	—	—	+	+	nd	+	+	+	+	+	+	+	—	ILN, MLN, BM

[a] ILN = inguinal; MLN = mesenteric lymph node; BM = bone marrow; LU = lung.
[b] nd = not done.

Yabsley et al., 2008, JWD

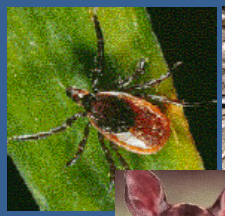
Past and Future

- A little information can go a long way in understanding the ecology of novel or understudied organisms
- But remember to constantly question and investigate


Amblyomma americanum
Ehrlichia chaffeensis
Ehrlichia ewingii
Ehrlichia sp. PME agent
Cytauxzoon felis
Borrelia lonestari??
Rickettsia amblyommii??
Bartonella spp.?

Babesia sp. MO1

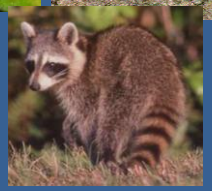
Babesia duncani



Ixodes scapularis* and *I. pacificus
Babesia microti
Borrelia burgdorferi
Anaplasma phagocytophilum

Suites

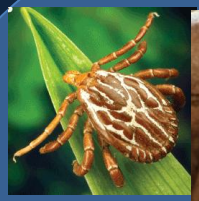




Dermacentor variabilis
Rickettsia rickettsii
Cytauxzoon felis

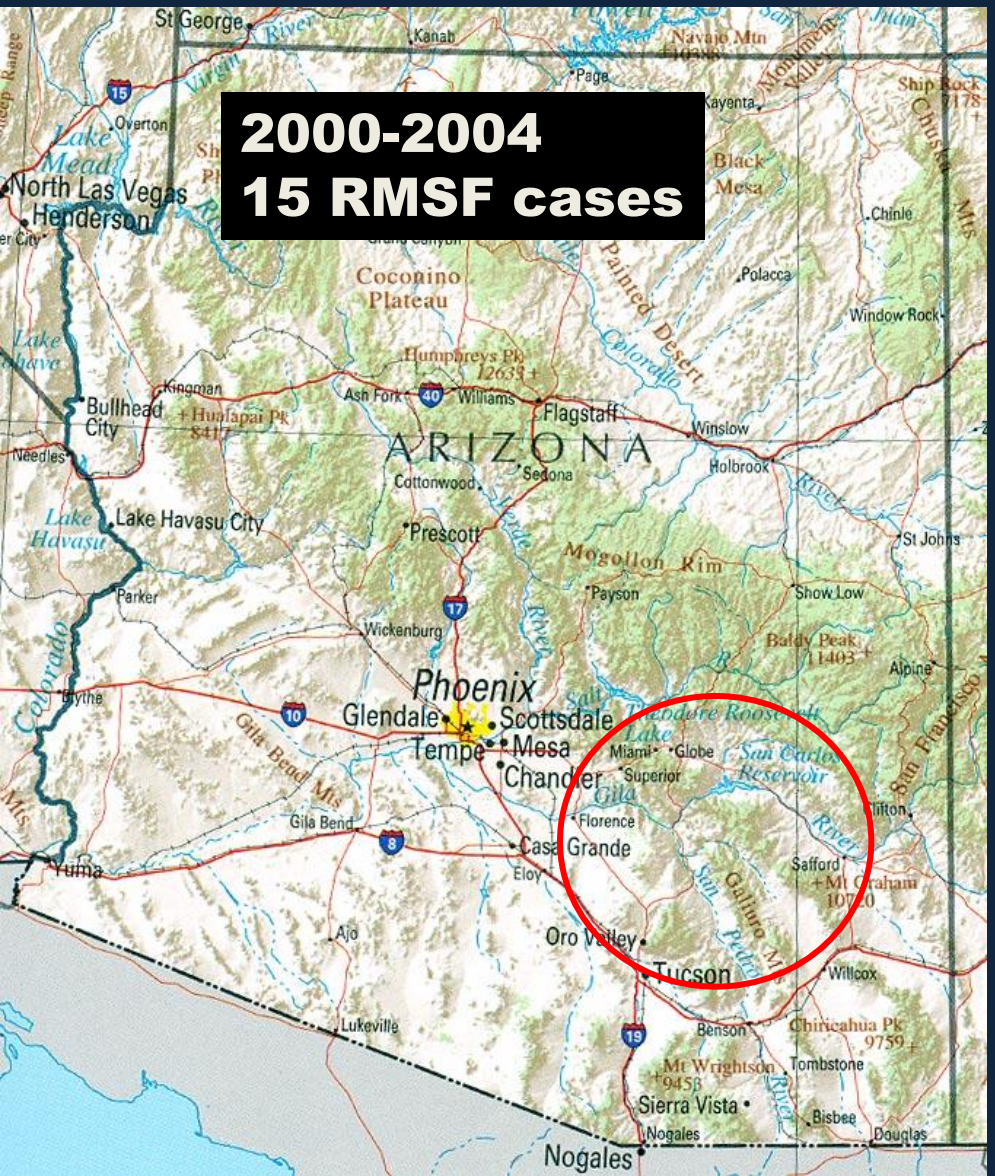
Bartonella spp. ??

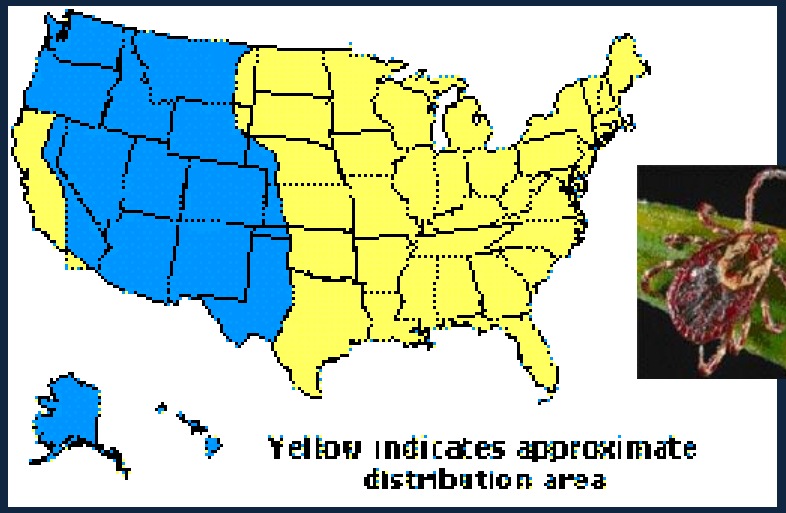
STARI agent?

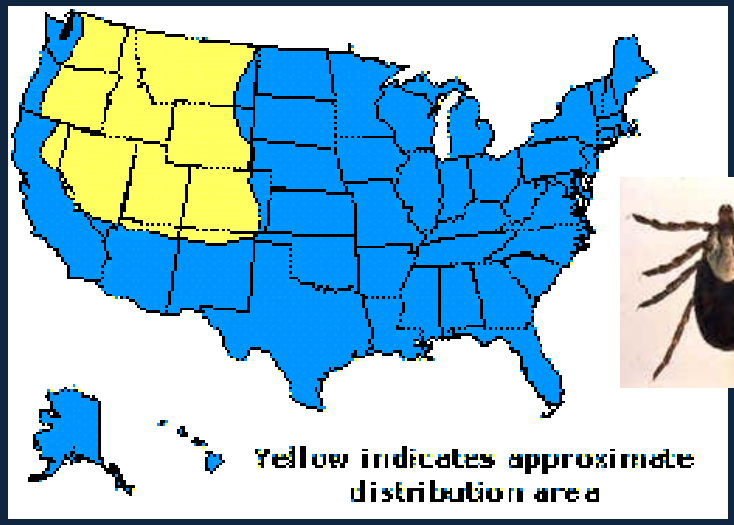



Amblyomma maculatum
Rickettsia parkeri
Hepatozoon americanum

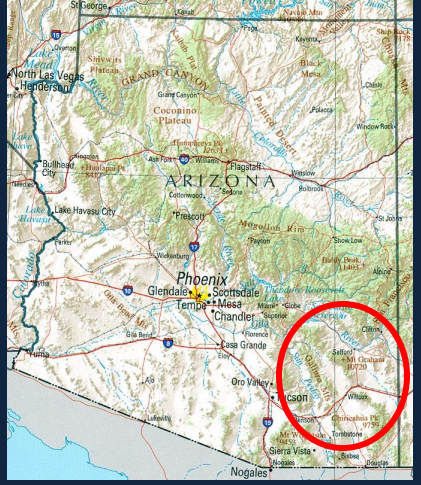
Old disease – Challenge to dogma



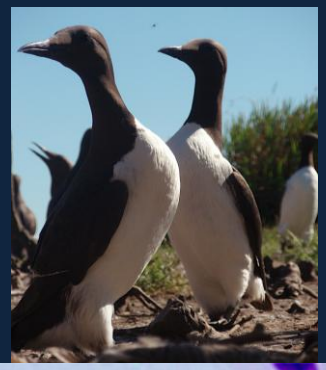


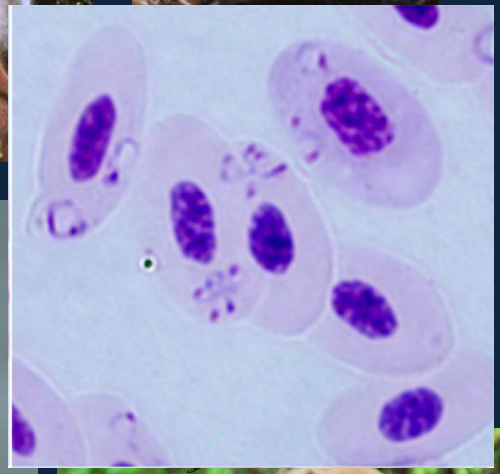


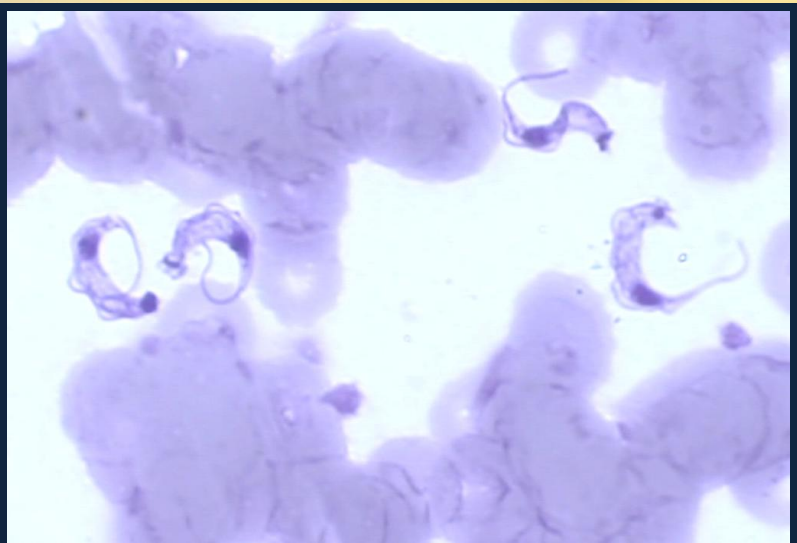
Rhipicephalus sanguineus (common brown dog tick)

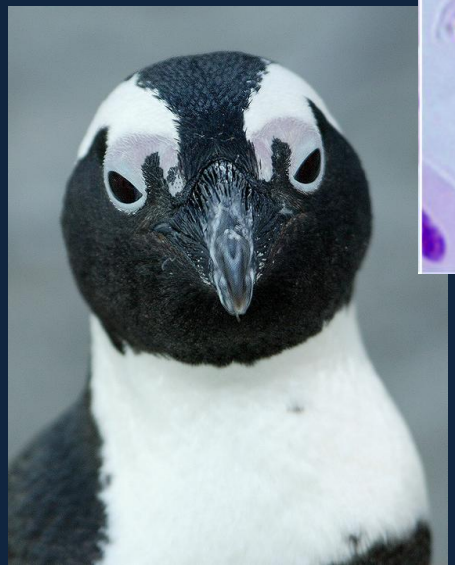


Trypanosoma cruzi and *Babesia*
A wildlife bonanza!









QUESTIONS?

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